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Three Feather Mites (Acari: Sarcoptiformes) Isolated from Black-Tailed Godwit, *Limosa limosa* in Korea

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ABSTRACT

Feather mites comprise two superfamilies (Analgoidea and Pterolichoidea) and are highly specialized ectosymbionts of birds. To date, this group contains more than 2,500 species worldwide. Fifty-five feather mite species have been reported in Korea, and only one species of genus *Alloptes* has been recorded from black-tailed godwit *Limosa limosa*. Three new records of feather mites from the *L. limosa* in Korea are added in this study: *Avenzoaria punctata* Gaud, 1972, *Bregetovia limosae* (Buchholz, 1869), and *Montchadskiana buchholzi* (Canestrini, 1878). The genus *Bregetovia* Dubinin, 1951 is also new report for this country. In this paper, we provide the morphological descriptions and illustrations based on the present specimens. Additionally, we determined partial sequences of the mitochondrial cytochrome *c* oxidase subunit I (*COI*) from three feather mites as DNA barcodes.

Keywords: *Avenzoaria punctata*, black-tailed godwit, *Bregetovia limosae*, *COI*, feather mite, Korea, *Montchadskiana buchholzi*

INTRODUCTION

Feather mites comprise two superfamilies (Acari: Sarcoptiformes: Analgoidea and Pterolichoidea) and are highly specialized ectosymbionts of birds (Mironov, 2003; Proctor, 2003; Oconnor, 2009). To date, this group contains more than 2,500 species worldwide (Mironov, 2003; Stefan et al., 2014). In Korea, 55 species have been reported (Tibbetts, 1955; Santana, 1976; Pérez and Atyeo, 1992; Han and Min, 2019a, 2019b, 2019c).

The family Avenzoariidae Oudemans, 1905 consists of two subfamilies (Avenzoariinae Oudemans, 1905 and Bonnetellinae Atyeo and Gaud, 1981), and is associated with a variety of aquatic birds (Gaud and Atyeo, 1996; Dabert et al., 2001; Oconnor, 2009; Stefan et al., 2014). The genera *Avenzoaria* Oudemans, 1905 and *Bregetovia* Dubinin, 1951 belong to the Avenzoariinae subfamily and contain 16 (including *A. gralatoris* and *A. limicolae*) and 6 species, respectively (Mironov et al., 1993; Badek and Dabert, 2005).

The family Pterolichidae Trouessart and Mégnin, 1884 contains over 400 species in approximately 120 genera and are found on diverse birds with the exception of those in the order Passeriformes (Gaud and Atyeo, 1996; Mironov and Dabert, 2010). The genus *Montchadskiana* belongs to the Pterolichidae family and contanis 17 species (Gaud and Atyeo, 1996; Dabert and Ehrnsberger, 1999).

The black-tailed godwit *Limosa limosa* (Linnaeus, 1758) breeds in grasslands with peat, clay, and sandy soil. These places can be found in blanket bogs and wet moorlands in central Eurasia (Gill et al., 2007). This species migrates to Africa, Southern Europe, India, Southeast Asia, and Australia and is known as a passage migrant bird in Korea (Lee et al., 2014; Park, 2014). Thus far, approximately 13 species of feather mites have been identified from black-tailed godwits worldwide (Bedford, 1936; Dubinin, 1951, 1956; Gaud, 1958, 1972, 1973; Zumpt, 1961; Gaud and Mouchet, 1963; Vasyukova and Mironov, 1991; Dabert and Ehrnsberger, 1999; Dabert, 2003). In Korea, only one species of the genus *Alloptes* has been recorded (Han and Min, 2019a).

Here, we recovered *A. punctata*, *B. limosae*, and *M. buchholzi* from the black-tailed godwit, and provide descriptions and illustrations of these three feather mites based on morphology. Additionally, we provide the partial sequences of the mitochondrial cytochrome *c* oxidase subunit I (*COI*) as DNA barcodes.

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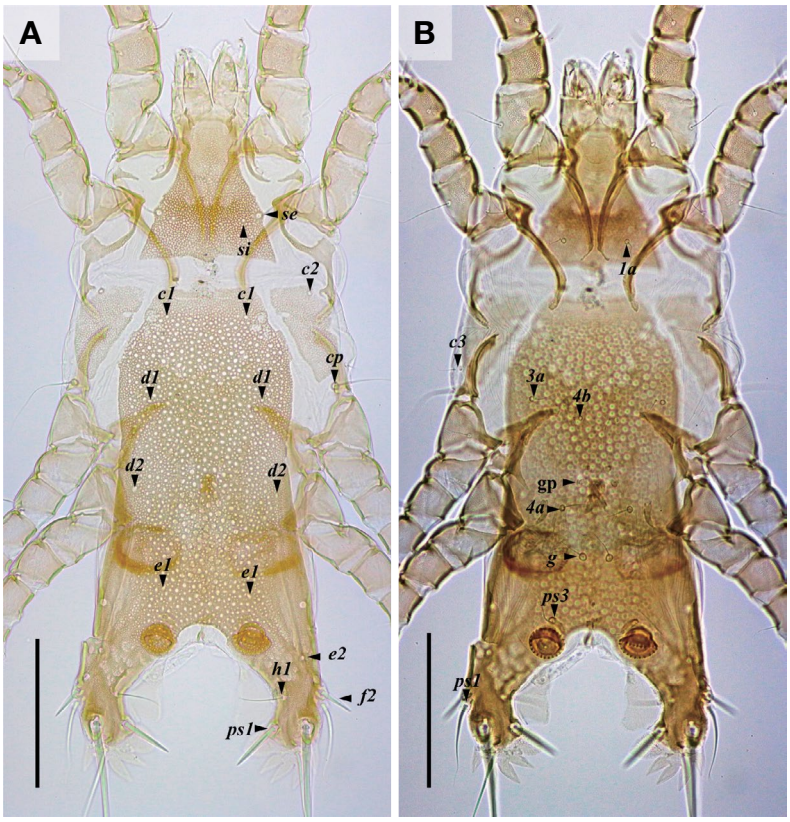

Fig. 1. *Avenzoaria punctata*, male. A, Dorsal view; B, Ventral view. gp, genital papillae. Scale bars: A, B = 0.1 mm.

MATERIALS AND METHODS

Two black-tailed godwits (CNWARC no. CN17-265 and CN12-402) were initially rescued from Asan and Seosan-si by the Chungnam Wild Animal Rescue Center (CNWARC) but later died and were stored in a −20°C freezer at this center. Mite samples were collected from flight feathers of wings using a vacuum machine. The collected mites were preserved directly in 95% ethyl alcohol. The mite specimens were cleared by lactic acid for 24 h and then mounted on micro slides using PVA mounting medium (Downs, 1943). The specimens were photographed using a microscopic digital camera (Leica, Wetzlar, Germany). The terms and measurements follow Gaud and Atyeo (1996) and Norton (1998). All examined specimens were deposited in the National Institute of Biological Resources (NIBR) and Inha University, Korea.

DNA sequencing

DNA was extracted from a leg of each specimen using a Tissue DNA Purification Kit (Cosmogenetech Inc., Seoul, Korea), according to the manufacturer's instructions. Partial sequences of the mitochondrial *COI* gene were amplified with two primers: bcdF05 5′-TTTTCTACHAAYCATAAAGATATTGC-3′ and bcdR04 5′-TATAAACYTCDGGATGNCCAAAAAA-3′ (Dabert et al., 2008). PCR condition, purification and sequencing were performed according to the methods described by Han et al. (2016).

SYSTEMATIC ACCOUNTS

Order Sarcoptiformes Canestrini, 1891
Family Avenzoariidae Oudemans, 1905
Genus *Avenzoaria* Oudemans, 1905

[1]** **Avenzoaria punctata* Gaud, 1972 (Figs. 1, 2)**

Avenzoaria punctata: Gaud, 1972: 37–42, figs. 16–17, 19; Vasyukova and Mironov, 1991: 23, 30, fig. 4.

Material examined. 1♂, 1♀, Korea, Chungcheongnam-do, Asan-si, Tangjeong-myeon, 36°48′58″N, 126°2′45″E, 18 May 2017, collected using vacuum machine from flight feathers

Korean name: [1]*얼룩반점날개깃진드기 (신칭)

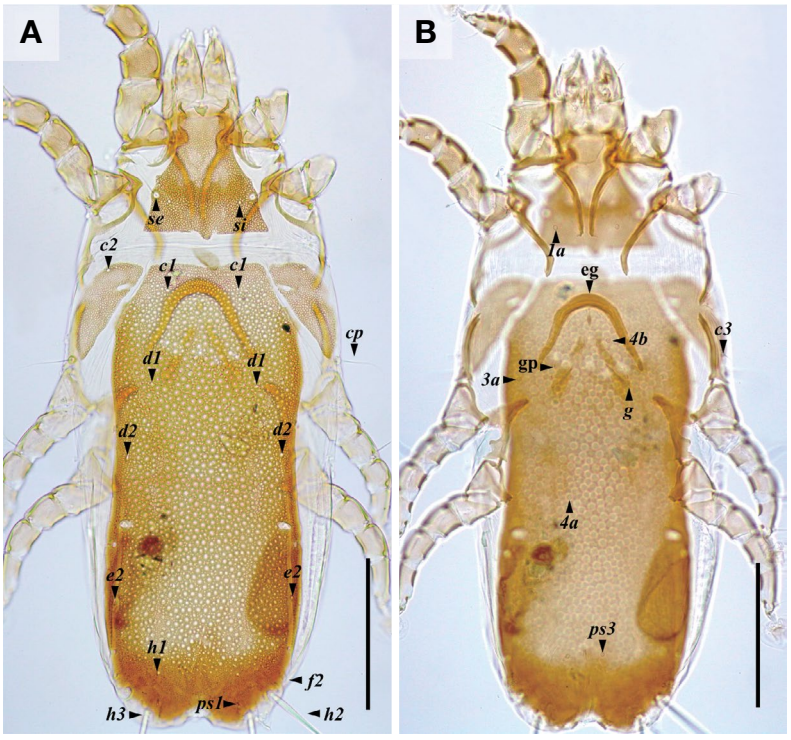

Fig. 2. *Avenzoaria punctata*, female. A, Dorsal view; B, Ventral view. eg, epigynum, gp, genital papillae. Scale bars: A, B=0.1 mm.

on the wings of black-tailed godwit *L. limosa* by Han YD.

Description. Male: Length 415 μm of idiosoma from anterior end to bases of setae *h3*, width 170 μm at level of humeral shields (Fig. 1A). Prodorsal shield (Fig. 1A): posterior margin with medial convex, posterior angles acute, with small round lacunae, length 98 μm along midline, width 75 μm at posterior part. Hysteronotal shield (Fig. 1A): Anterior part straight, with irregularly round lacunae, length 350 μm from anterior margin to bases of setae *h3*, width 113 μm at level of setae *d1*. Interlobar cleft transversal oval-shaped, with anterior part concave. Interlobar membrane expanded at the distal edges of the lobes. Incision in interlobar membrane elongated oval. Postlobar membranes with one rounded and four acute teeth. Sternum (Fig. 1B): epimerites I not fused. Genital apparatus l situated between levels of trochanters III and IV. Genital papillae located anterior to base of genital apparatus (Fig. 1B).

Female: Idiosoma size 420 × 180 μm (length × width) (Fig. 2A). Prodorsal shield (Fig. 2A): Mostly shaped as in male, length along middle line 92 μm, width 82 μm at posterior part. Hysteronotal shield (Fig. 2A): Shaped as in male, posterior part with stronger sclerotization, length 310 μm, width 125 μm. Opisthosoma terminus round-shape. Terminal cleft small semicircular. Sternum (Fig. 2B): epimerites I shaped as in male. Epigynum horseshoe-shaped, with each side by slightly concavity at level of setae *4b*, length 53 μm, width 73 μm at posterior margins. ends of epigynum extending to level of genital papillae.

Remarks. *Avenzoaria punctata* was originally described by Gaud (1972) based on specimens collected from *L. limosa* in Morocco. Thereafter, this species was reported by Vasyukova and Mironov (1991) from *Limosa lappoinca* in the Sakha Republic (=Yakutia Republic) of Russia.

Avenzoaria punctata has very similar external traits to *A. arenarii* Dubinin, 1951 and *A. tringae* (Oudemans, 1904). However, *A. punctata* can be clearly distinguished from *A. arenarii* and *A. tringae* by the following characteristics: hysteronotal shield has small round ornamentation; in male, postlobar membranes consist of single-rounded and four pointed teeth; in female, posterior ends of epigynum are extend to level of genital papillae (Gaud, 1972; Vasyukova and Mironov, 1991). The Korean specimens were morphologically consistent with the original descriptions and illustrations provided by Gaud (1972).

Host. This species was found on wings feathers of the black-tailed godwit *L. limosa*.

Distribution. Morocco (Gaud, 1972), Russia (Vasyukova and Mironov, 1991), Korea (this study).

Deposition. NIBR No. NIBRIV0000835097–0000835098.

Molecular characteristics. The *COI* sequences were obtain-

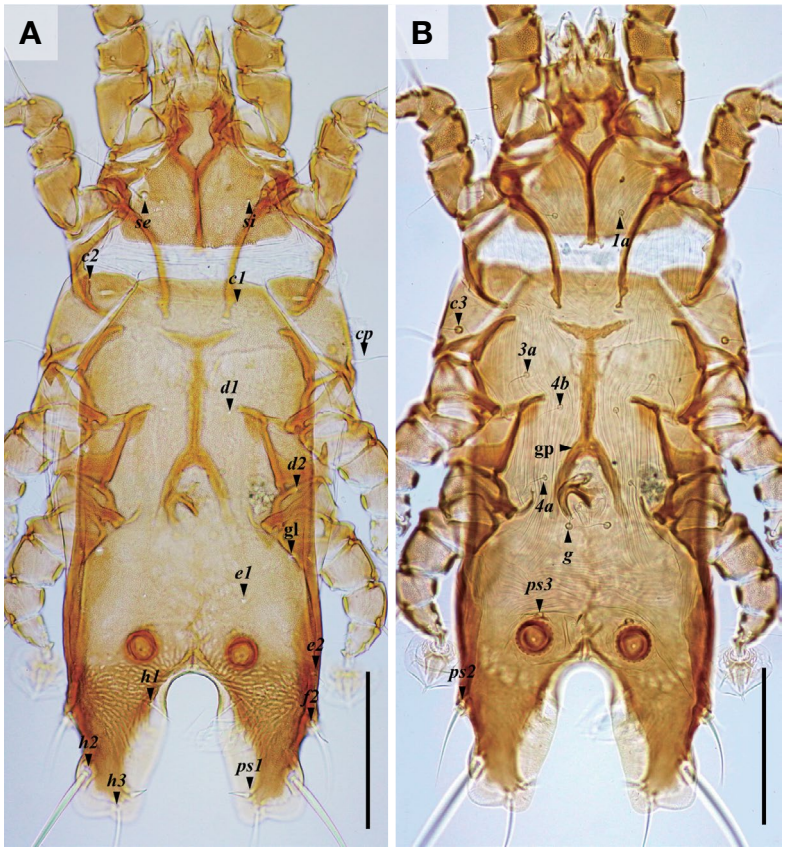

Fig. 3. *Bregetovia limosae*, homeomorphic male. A, Dorsal view; B, Ventral view. gp, genital papillae. Scale bars: A, B = 0.1 mm.

ed from single individual and deposited in GenBank with accession numbers of MK085955.

[1*]Genus *Bregetovia* Dubinin, 1951

[2*]***Bregetovia limosae* (Buchholz, 1869) (Figs. 3–5)**

Dermaleichus limosae: Buchholz, 1869: 26, figs. 12–13.

Pterolichus limosae: Mégnin and Trouessart, 1884: 337; Oudemans, 1904: 194.

Bregetovia limosae: Dubinin, 1951: 178–180, fig. 38, 1956: 415–419, figs. 199–200; Zumpt, 1961: 269, fig. 165; Vasyukova and Mironov, 1991: 37–40, figs. 22, 25; Mironov, 1992: 128–144, figs. 1, 4, 6.

Material examined. 2♂♂ (Homeomorphic type), 2♂♂ (Mesomorphic type), 3♀♀, Korea, Chungcheongnam-do, Asan-si, Tangjeong-myeon, 36°48′58″N, 126°2′45″E, 18 May 2017, collected using vacuum machine from flight feathers on the wings of black-tailed godwit *L. limosa* by Han Y.-D.

Description. Homeomorphic male: Length 470–475 μm of idiosoma from anterior end to base of the setae *h3*, width 205–210 μm at level of humeral shields (Fig. 3A). Prodorsal shield (Fig. 3A): Triangle-shaped, with small protrusions at anterior to bases of setae *se*, length 108 μm along midline, width 113 μm at posterior margin, without seta *vi*. Hysteronotal shield (Fig. 3A): Anterior margin straight, lateral margins with small rounded extensions, length 350 μm from anterior margins to base of setae *h3*, width 150–155 μm at level of small rounded extensions. Opisthosomal lobes almost straight-shaped and blunt at the cleft apex, with irregular longitudinal wavy striation between setae *e2* and cleft apex. Interlobar membrane expanded at the entire edges of the terminal cleft and not narrowing to bases of setae *h2*. Sternum (Fig. 3B): Epimerites I fused in to a Y-shape, with transversal sclerite on the posterior end. Setae *c3* located outside ventral margins of the humeral shield. Epiandrium extended anteriorly by long T-shaped sclerite and posterior parts inverted Y-shaped, with genital papillae on stem of Y.

Mesomorphic male: Length 445–455 μm of idiosoma from anterior end to base of the setae *h3*, width 185–200 μm at

Korean name: [1*]새총날개깃진드기속(신칭), [2*]흑꼬리도요새총날개깃진드기(신칭)

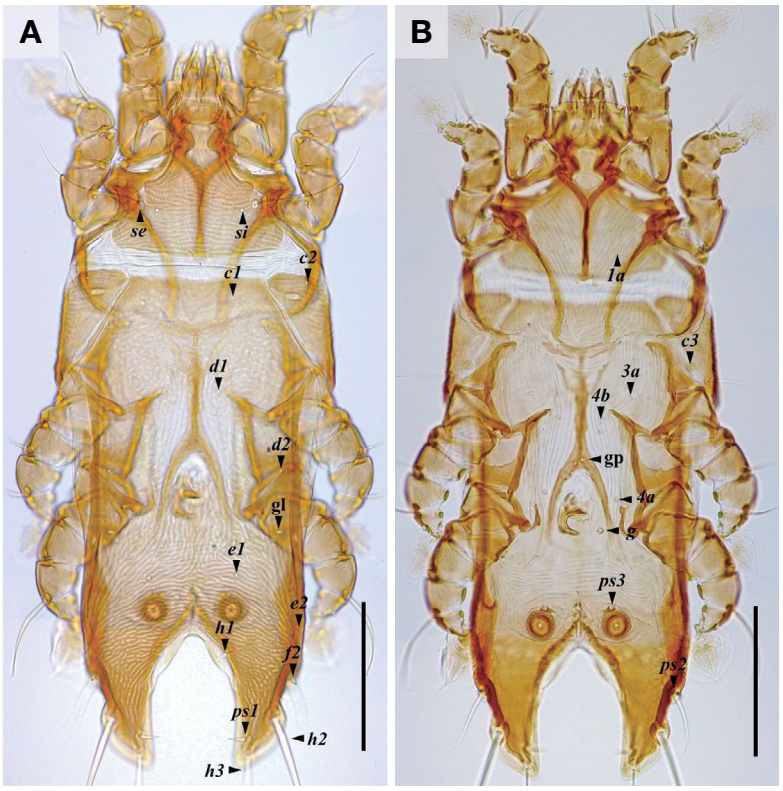

Fig. 4. *Bregetovia limosae*, meosomorphic male. A, Dorsal view; B, Ventral view. gp, genital papillae. Scale bars: A, B = 0.1 mm.

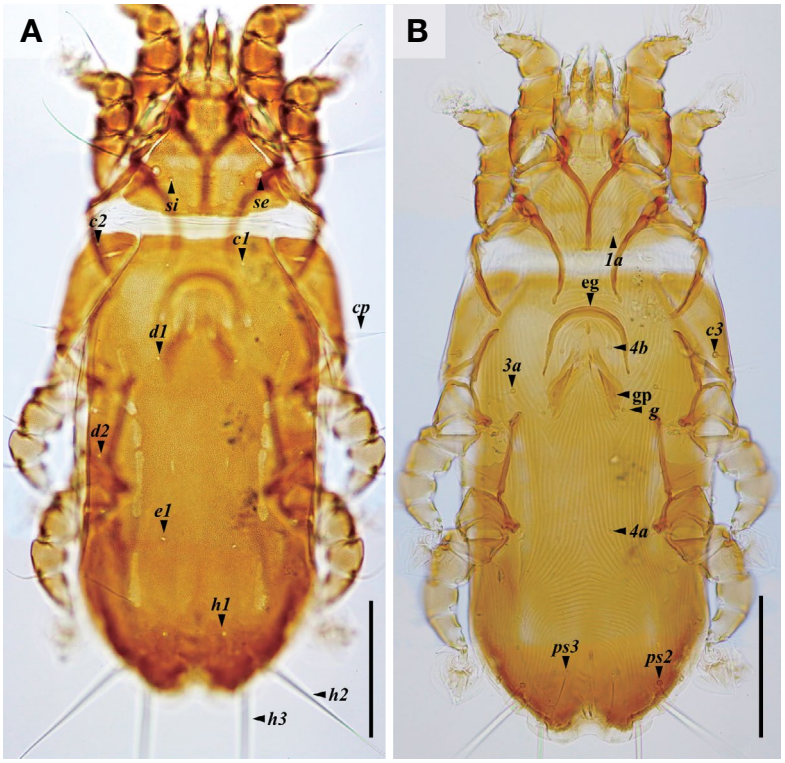

Fig. 5. *Bregetovia limosae*, female. A, Dorsal view; B, Ventral view. eg, epigynum, gp, genital papillae. Scale bars: A, B = 0.1 mm.

level of humeral shields (Fig. 4A). Prodorsal shield (Fig. 4A): Shaped as in homeomorphic male, entire surface with transversal wavy striation, length 100–110 μm along midline, width 115–117 μm at posterior margin. Hysteronotal shield (Fig. 4A): Anterior part straight, with transversal wavy striation excluding lobar part, length 325 μm from anterior margin to base of setae *h3*, width 77–80 μm. Opisthosomal lobes short and round-shaped at the apex. Setae *h3* long and hair-like shaped. Sternum (Fig. 4B): Shaped as in homeomorphic male, posterior end of epimerites I not connected epimerites II. pretarsi of legs I with acuminate processes. The femurs of leg II with narrow and blunt ventral process.

Female: Idiosoma size 455–465 × 210–230 μm (length × width) (Fig. 5A). Prodorsal shield (Fig. 5A): Shaped as in male. Length 102–107 μm, width 120–123 μm at posterior part. Hysteronotal shield (Fig. 5A): Anterior part straight, length 330–350 μm, width 175–180 μm. Setae *c3* situated outside ventral margins of the humeral shield. The posterior part of opisthosoma round-shaped, with medial incision. Sternum (Fig. 5B): Epimerites I fused, posterior end with lateral protuberances. Epigynum thick and semicircular, length 50–55 μm, width 63–75 μm. Ambulacral disks of legs IV extending posterior of the body margin.

Remarks. *Bregetovia limosae* was originally described by Buchholz (1869) based on specimens collected from *L. limosa* in Europe.

Bregetovia limosae possesses similar to external traits *B. mucronata* (Mégnin and Trouessart, 1884) and *B. selenura* (Mégnin and Trouessart, 1884). However, *B. limosae* can be clearly distinguished from *B. mucronata* and *B. selenura* by the following characteristics: in males, setae *c3* are located outside the ventral margin of the humeral shields; in mesomorphic males, apex of opisthosomal lobes are comparatively thick and rounded; in female, ambulacral disc of leg IV is extends to posterior part of idiosoma (Mironov, 1992). Korean specimens were morphologically consistent with the description and illustrations provided in the literature (Dabert and Ehrnsberger, 1999).

Host. This species was found on wing feathers of the black-tailed godwit *L. limosa*.

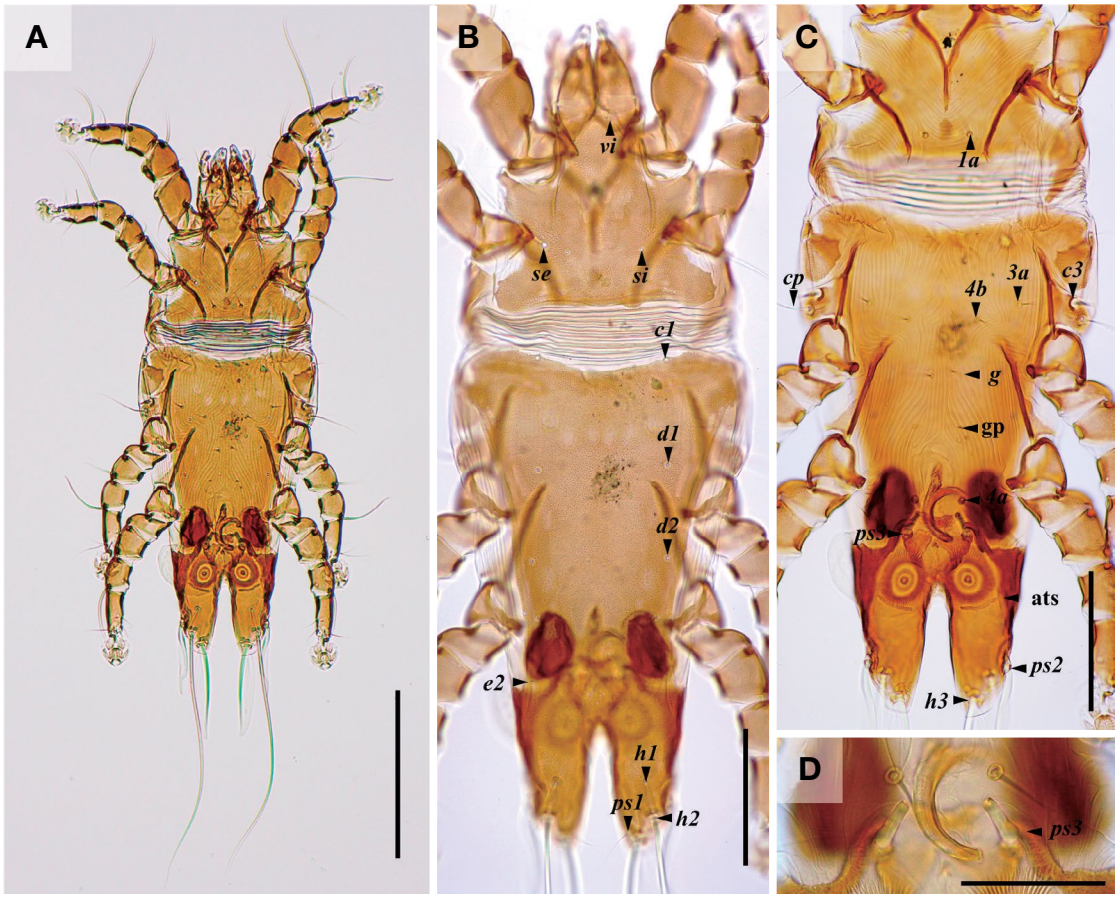

Fig. 6. *Montchadskiana buchholzi*, male. A, Dorsal veiw; B, Dorsal idisosoma; C, Ventral idisosoma; D, Genital area. ats, additional transversal sclerites, gp, genital papillae. Scale bars: A = 0.2 mm, B, C = 0.1 mm, D = 0.05 mm.

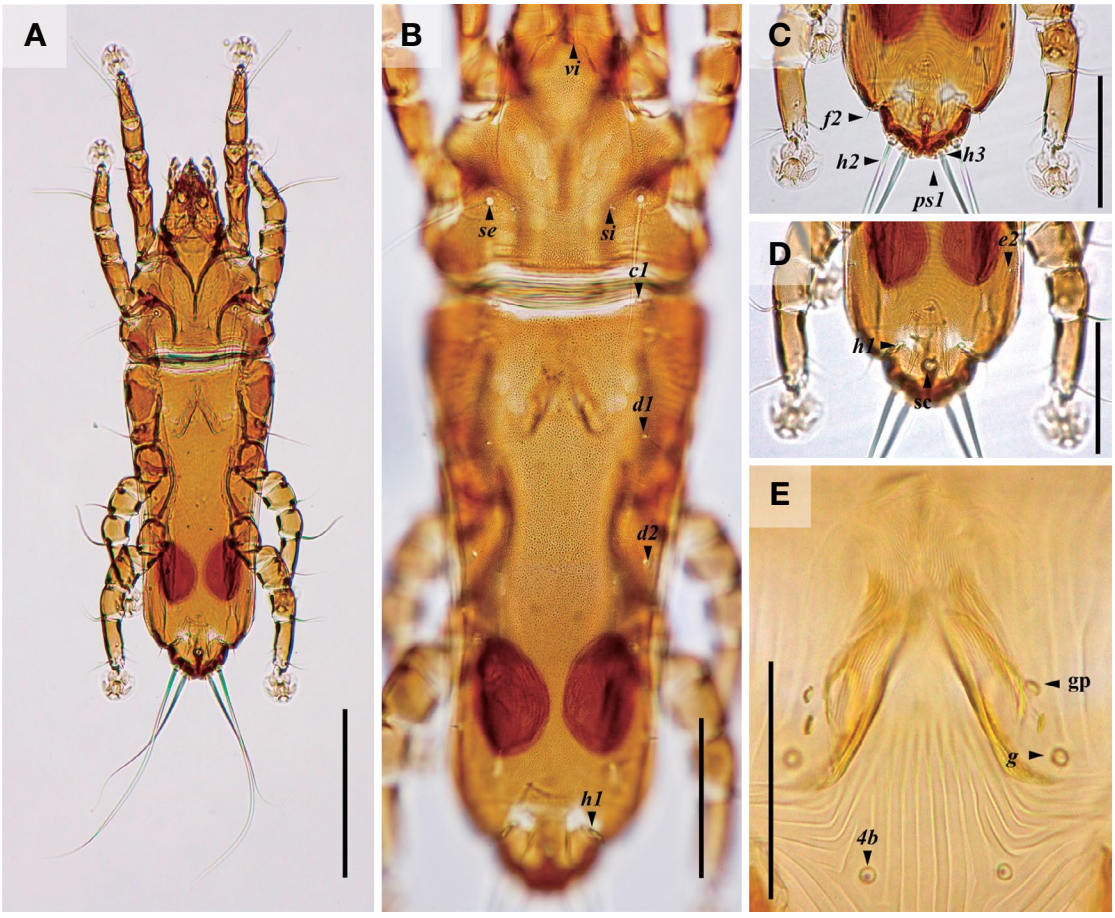

Fig. 7. *Montchadskiana buchholzi*, female. A, Dorsal veiw; B, Dorsal idisosoma; C, Ventral opisthosoma; D, Dorsal opisthosoma; E, Genital area. gp, genital papillae, sc, supranal concavity. Scale bars: A=0.2 mm, B–D=0.1 mm, E=0.05 mm.

Distribution. Ethiopia (Zumpt, 1961), Europe (Buchholz, 1869), France, Germany, Italy, Russia (Dubinin, 1951; Vasyukova and Mironov, 1991; Mironov, 1992), Korea (this study).
Deposition. NIBR No. NIBRIV0000849808–0000849814.
Molecular characteristics. The *COI* sequences were obtained from three individuals and deposited in GenBank with accession numbers of MK085956–MK085958.

Family Pterolichidae Trouessart and Mégnin, 1884
Genus *Montchadskiana* Dubinin, 1951

[1]***Montchadskiana buchholzi*** **(Canestrini, 1878)**
(Figs. 6, 7)

Dermaleichus Buchholzi: Canestrini, 1878: 64.
Proctophyllodes Buchholzi: Canestrini, 1879: 37, Pl. I–III, fig. 12.
Montchadskiana buchholzi: Dubinin, 1951: 168, fig. 31, 1956: 466–469, fig. 226; Gaud, 1972: 76–77; Vasyukova & Mironov, 1991: 127; Dabert, 1997: 244; Dabert and Ehrnsberger, 1999: 234–235, figs. 17, 22.

Material examined. 3♂♂, 3♀♀, Korea, Chungcheongnam-do, Seosan-si, Taesoan-eup, 37°0′12″N, 126°24′5″E, 6 Jul 2012, collected using vacuum machine from flight feathers on the wings of black-tailed godwit *L. limosa* by Han YD.
Description. Male: Idiosoma (Fig. 6A): length 530–540 μm of idiosoma from anterior end to base of the setae *h3*, width 195–230 μm at level of humeral shields, length to width ratio 2.3–2.7. Prodorsal shield (Fig. 6B): Covers the entire prodorsum, length 137–140 and width 153–162 μm, with two *vi* setae. Hysteronotal shield (Fig. 6B): Anterior margin slightly concave, with transversal striation between setae *c1* and *d1*, length 360–365 μm from anterior margin to base of setae *h3*, width 185–195 μm at anterior part. Sternum (Fig. 6C): Epimerites I fused. Genital apparatus long and massive. Adanal shields consist of one horizontal sclerite located posterior to

Korean name: [1]*흑꼬리도요깃사이진드기 (신칭)

the genital apparatus and two triangular sclerites carrying setae *ps3*. Additional transversal sclerites located posterior to adanal discs. Setae *ps3* lanceolate, with extension at the base and bidentate apex (Fig. 6D).

Female: Length 510−525 μm of idiosoma from anterior end to bases of setae *h3*, width 195−230 μm at level of humeral shields, length to width ratio 2.2−2.6 (Fig. 7A). Prodorsal shield (Fig. 7B): Shaped as in male. Length 145−148 μm at based of setae *vi*, width 165−175 μm at posterior part. Hysteronotal shield (Fig. 7B, C): Anterior part slightly concave, with horizontal striation at the base from setae *c1* to setae *d1*, lateral margins with horizontal incisions at bases of setae *h1*, length 365−380 μm, width 375−400 μm at based of setae *c2*. Setae *h1* lanceolate. Supranal concavity circular-shaped, divided from terminal terminus, flanked with a pair of tongue-shaped crests (Fig. 7D). Epigynum absent (Fig. 7E).

Remarks. *Montchadskiana buchholzi* was originally described by Buchholz (1869) based on specimens collected from *L. limosa* (=*Limosa melanura*) in Europe. Thereafter, this species was reported from *L. limosa* and *L. lappoinca* by several mite taxonomists (Canestrini, 1878; Dubinin, 1951, 1956; Gaud, 1972; Vasyukova and Mironov, 1991; Dabert and Ehrnsberger, 1999).

Montchadskiana buchholzi is very similar to *M. calidridis* Dubinin, 1956 and *M. glareolae* Dabert & Ehrnsberger, 1999 with regard to external traits. However, *M. buchholzi* can be clearly distinguished from *M. calidridis* and *M. glareolae* by the following characteristics: in males, adanal shield is comprised of single transversal and two triangular sclerites, and additional two transversal sclerites are located posterior to adanal discs; in female, lateral margins of hysteronotal shield have transversal incisions at bases of setae *h1*, and one pair of tongue-shaped crests are situated on both sides of the supranal concavity (Dabert and Ehrnsberger, 1999). Korean specimens well agreed with the description and illustrations that described by Dabert and Ehrnsberger (1999).

However, setae *ps3* of all observed males have a basal extension and a slightly bidentate apex. We consider this difference to be and geographical or population variability.

Host. Specimens were collected from the surface of flight feathers on the wings of the black-tailed godwit *L. limosa*.

Distribution. Europe (Canestrini, 1878), France, Morocco (Gaud, 1972), Poland (Dabert and Ehrnsberger, 1999), Russia (Dubinin, 1951, 1956; Vasyukova and Mironov, 1991), and Korea (this study).

Deposition. NIBR No. NIBRIV0000835099, NIBRIV0000843277−0000843281.

Molecular characteristics. The *COI* sequences were obtained from single individual and deposited in GenBank with accession numbers of MK791137.

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REFERENCES

Badek A, Dabert J, 2005. A new species of the genus *Avenzoaria* Oudemans, 1905 (Acari: Avenzoariidae) from the red knot, *Calidris canutus* (L.) (Aves, Charadriiformes). Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg, 14:237-243.

Bedford GAH, 1936. A synoptic checklist and hostlist of the ectoparasites found on South African Mammalia, Aves and Reptilia (Supplement No. 1). Onderstepoort Journal of Veterinary Science and Animal Industry, 7:69-110.

Buchholz R, 1869. Bemerkungen über die Arten der Gattung Dermaleichus Koch. Nova Acta Lecpoldina Deutsche Akademie der Naturforscher, 35:1-56.

Canestrini G, 1878. Nouve specie del genre *Dermaleichus*. Atti del Reale Istituto Veneto di Scienze, Lettere ed Arti, 5:43-70.

Canestrini G, 1879. Intorno ad alcuni Acari parassiti. Atti della Società Veneto-Trentina de Scienze Naturali, 6:32-42.

Dabert J, 1997. Psoroptides: Analgoidea, Freyanoidea, Pterolichoidea. In: Checklist of animals of Poland, 4 (Ed., Razowski J). Wydawnictwa Instytutu Systematyki i Ewolucji Zwierzat PAN, Cracov, pp. 242-247.

Dabert J, 2003. The feather mite family Syringobiidae Trouessart, 1896 (Acari, Astigmata, Pterolichoidea). I. Systematics of the family and description of new taxa. Acta Parasitologica, 48:S1-S184.

Dabert J, Dabert M, Mironov SV, 2001. Phylogeny of feather mite subfamily Avenzoariinae (Acari: Analgoidea: Avenzoariidae) inferred from combined analyses of molecular and morphological data. Molecular Phylogenetics and Evolution, 20:124-135. https://doi.org/10.1006/mpev.2001.0948

Dabert J, Ehrnsberger R, 1999. Systematics of the feather mite genus *Montchadskiana* Dubinin, 1951 (Pterolichoidea, Pterolichidae, Magimeliinae) with description of five new species. Acta Zoologica Cracoviensia, 42:219-249.

Dabert J, Ehrnsberger R, Dabert M, 2008. *Glaucalges tytonis* sp. nov. (Analgoidea: Xolalgidae) from the barn owl *Tyto alba* (Strigiformes: Tytonidae): compiling morphology with DNA barcode data for taxa descriptions in mites (Acari). Zootaxa, 1719:41-52.

Downs WG, 1943. Polyvinyl alcohol: a medium for mounting

and clearing biological specimens. Science, 97:539-540. https://doi.org/10.1126/science.97.2528.539

Dubinin VB, 1951. Feather mites of birds of the Baraba Steppe. Report I. Feather mites of waterfowl and wading birds of the orders of rails, grebes, palmipedes, anserines, herons, gulls, and limicoles. Parazitologicheskii Sbomik, 13:120-256 (in Russian).

Dubinin VB, 1956. Feather mites (Analgesoidea). Part III. Family Pterolichidae. Fauna USSR, Paukoobraznye, 6:1-813 (in Russian).

Gaud J, 1958. Acariens plumicoles (Analgesoidea) parasites des oiseaux du Maroc II. Analgesidae. Bulletin de la Société des Sciences Naturelles et Physiques du Maroc, 37:27-49.

Gaud J, 1972. Acariens sarcoptiformes plumicoles (Analgoidea): parasites sur les oiseaux charadriiformes d'Afrique. Annales du Musée Royal de l'Afrique Centrale, Serie 8: Sciences Zoologiques, 193:1-116.

Gaud J, 1973. Quelques espèces nouvelles de Sarcoptiformes plumicoles (Analgidae & Dermoglyphidae) parasites d'oiseaux d'Europe. Acarologia, 15:727-758.

Gaud J, Atyeo WT, 1996. Feather mites of the world (Acarina, Astigmata): the supraspecific taxa. Part I Text. Annales du Musée Royale de l'Afrique Centrale, Serie 8: Sciences Zoologiques, 214:1-193.

Gaud J, Mouchet J, 1963. Révision des genres *Grallobia* Hull et *Grallolichus* Gaud (Pterolichidae, Sarcoptiformes). Acarologia, 5:628-643.

Gill JA, Langston RHW, Alves JA, Atkinson PW, Bocher P, Vieira NC, Crockford NJ, Gélinaud G, Groen N, Gunnarsson TG, Hayhow B, Hooijmeijer J, Kentie R, Kleijn D, Lourenço PM, Masero JA, Meunier F, Potts PM, Roodbergen M, Schekkerman H, Schröder J, Wymenga E, Piersma T, 2007. Contrasting trends in two black-tailed godwit populations: a review of causes and recommendations. Wader Study Group Bulletin, 114:43-50.

Han YD, Min GS, 2019a. Four unrecorded species of genus *Alloptes* (Acari: Sarcoptiformes: Alloptidae) from charadriiform birds in South Korea. Animal Systematics, Evolution and Diversity, 35:63-72. https://doi.org/10.5635/ASED.2019.35.2.005

Han YD, Min GS, 2019b. New record of two feather mites (Acari: Sarcoptiformes: Astigmata) isolated from *Actitis hypoleucos* in South Korea. Journal of Spceies Research, 8:225-232.

Han YD, Min GS, 2019c. Three feather mites (Acari: Sarcoptiformes: Astigmata) isolated from *Tringa glareola* in South Korea. Journal of Spceies Research, 8:215-224.

Han YD, Song JH, Min GS, 2016. New record of two feather mites (Acari: Saroptiforems: Astigmata) from Korea. Journal of Species Research, 5:324-332. https://doi.org/10.12651/JSR.2016.5.3.324

Lee WS, Koo TH, Park JY, 2014. A field guide to the birds of Korea. LG Evergreen Foundation, Seoul, pp. 1-328.

Mégnin P, Trouessart EL, 1884. Les Sarcoptides plumicoles. The Journal of Micrographics, 8:337.

Mironov SV, 1992. Review of the species of the genus *Bregetovia* Dubinin (Analgoidea, Avenzoariidae) from USSR fauna. Parazitol, 37:126-150 (in Russian).

Mironov SV, 2003. On some problems in the systematics of feather mites. Acarina, 11:3-29.

Mironov SV, Dabert J, 2010. Systematic revision of the feather mite genus *Protolichus* Trouessart, 1884 (Astigmata, Pterolichidae). Zootaxa, 2526:1-36. https://doi.org/10.11646/zootaxa.2526.1.1

Mironov SV, Dabert J, Atyeo WT, 1993. A new species of the feather mite genus *Bregetovia* Dubinin (Analgoidea, Avenzoariidae) with notes on the systematics of the genus. Entomologische Mitteilungen aus dem Zoologischen Museum, Hamburg, 11:75-87.

Norton RA, 1998. Morphological evidence for the evolutionary origin of Astigmata (Acari: Acariformes). Experimental and Applied Acarology, 22:559-594.

Oconnor RM, 2009. Astigmatina. In: A manual of acarology (Eds., Krantz GW, Walter DE). Texas Tech University Press, Lubbock, TX, pp. 565-657.

Oudemans AC, 1904. Acarologische Aanteekeningen XIV. Entomologische Berichten, 1:190-195.

Park J, 2014. Identification guide to birds of Korea. Nature & Ecology, Seoul, pp. 1-680.

Pérez TM, Atyeo WT, 1992. A review of the Xoloptoidinae (Acari, Pterolichidae) and the description of a new genus. Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg, 10:209-219.

Proctor HC, 2003. Feather mites (Acari: Astigmata): ecology, behavior, and evolution. Annual Review of Entomology, 48:185-209. https://doi.org/10.1146/annurev.ento.48.091801.112725

Santana FJ, 1976. A review of the genus *Trouessartia* (Analgoidea: Alloptidae). Journal of Medical Entomology, 13:1-125. https://doi.org/10.1093/jmedent/13.Suppl1.1

Stefan LM, McCoy KD, Mironov SV, 2014. A new species of the feather mite genus *Rhinozachvatkinia* (Acari: Avenzoariidae) from Calonectris shearwaters (Procellariiformes: Procellariidae): integrating morphological descriptions with DNA barcode data. Folia Parasitologica, 61:90-96.

Tibbetts T, 1955. A new nasal mite from a Korean woodpecker. Proceedings of the Entomological Society of Washington, 57:197-201.

Vasyukova TT, Mironov SV, 1991. Feather mites of Anseriformes and Charadriiformes of Yakutia: systematics. Novosibirsk, Nauka, pp. 1-201.

Zumpt F, 1961. The arthropod parasites of vertebrates in Africa south of the Sahara (Ethiopian region). Vol. 1. (Chelicerata). Publications of the South African Institute for Medical Research, 50:1-457.

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